DOCUMENT RESUME

ED 189 059 SP 016 244

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TITLE The Effect of Considering Student Opportunity to Learn in Teacher Behavior Research. Research Report No. 7.
INSTITUTION Texas Univ., Austin. Research and Development Center for Teacher Education.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE Aug 76
CONTRACT NIE-C-74-0088
NOTE 81p.

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Ability Grouping; Achievement Rating; *Educational Opportunities; Elementary Secondary Education; *Evaluation Methods; Predictive Measurement; Predictor Variables; *Statistical Analysis; *Teacher Behavior; Teacher Influence; *Time Factors (Learning)

ABSTRACT

Part of the Evaluation of Teaching Project (EOTP), this research report uses statistical analysis to examine: 1) whether students who had an opportunity to learn classroom material differ in posttest achievement from those students who did not have sufficient time to learn, 2) whether the relationships between teacher behaviors and student achievement differ for different pupil-ability groups, and 3) whether teacher behavior characteristics are related to pupil achievement for students with the opportunity to learn. Thirty-two fifth grade classes were pretested to determine their high, middle, or low learning ability. The 950 students were then taught from the same curriculum guide, rated by their teachers on their opportunity to learn, and tested. It was also found that teacher behavior is an insignificant variable in the prediction of student achievement. Discussion of data and evaluation problems and statistical charts are included. (CJ)

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ED189059

# The Effect of Considering Student Opportunity to Learn in Teacher Behavior Research

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Research Report No. 7

August 1976

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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SP016244

The research reported herein was supported in part by National Institute of Education Contract NIE-C-74-0088, Research and Development Center for Teacher Education. The opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education and no official endorsement by that office should be inferred.

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Investigations into the nature of effective teaching have explored a diversity of variables in an effort to find promising relationships between teacher behavior and student learning. An important consideration which has sometimes been overlooked in investigations of effective teaching is the appropriateness of the criterion measure which is used to assess pupil growth (Flanders, 1970; Rosenshine and Furst, 1971). As Flanders (1970, p. 377) has pointed out, error will be introduced into a study of teacher effectiveness when an achievement test used as a criterion does not adequately measure the knowledge and skills which the teacher attempted to teach. This situation may occur whenever standarized tests are used as the criterion measure without a careful examination of its items to ensure their relevance to the content presented or skills taught.

To avoid this potential source of invalidity in measuring outcome behavior it is important to establish that the measures of pupil achievement used in teacher effectiveness research are logical consequences of the teaching behavior in question. This can be accomplished by first identifying the content areas and specific objectives most likely to be covered during the time period of interest and selecting or constructing an appropriate achievement test and, secondly, determining whether the teacher did in fact cover the planned curriculum objectives. This latter variable is an index of whether students actually had an opportunity to acquire the skills and knowledge being tested. Student opportunity to learn the criterion material has been found to be a significant correlate of student achievement (Rosenshine and Furst, 1971). Investigations of student opportunity to learn will be briefly reviewed for the purpose of presenting the different approaches and operational definitions used in the measurement of this variable.

In their review of research on teacher performance criteria, Rosenshine and Furst (1971) cite four studies in which the relationship between opportunity to learn and student achievement was explored. Rosenshine (1968b) inspected typescripts of 15-minute lessons to determine the total number of words in the lesson which were relevant to the material on the posttest. The significant correlations obtained in this study were interpreted as a measure of the degree to which teachers trained their students on the criterion items.

In a similar study (Shutes, 1969), coders viewed 32 video-tapes of 40-minute lessons selected from 104 lessons on the basis of class mean scores on post-lesson achievement tests. The sample contained 16 lessons with the highest class mean scores and 16 lessons with lowest class mean scores, which were rated on 11 variables, one of which was relevance of lesson content to test items. The author reported that although "low" lessons had significantly lower content relevance scores, content coverage proved an unreliable predictor of percent of correct student responses to test items.

In a cross-cultural study of achievement in mathematics (Husen, 1967), teachers were asked to indicate to what extent items on the achievement test were appropriate for their students. Each question on the test was examined by each teacher, who indicated whether "all or most" (at least 75%), "some" (25% to 75%), or "few or none" (under 25%) of his or her group of students had had an opportunity to learn that type of problem. Correlations calculated between the teachers' ratings and the pupils' scores on the tests rated indicated a small but statistically significant positive relationship between these two variables.

Finally, Rosenshine and Furst (1971) reported that when the amount of time spent on various topics within four hour-long lessons were related to student achievement, it failed to result in significant findings (Bellack,

Kleibard, Hyman, and Smith, 1966). Although this operational definition of opportunity to learn appears relevant and valid, the reviewers suggested that the lack of significant results may have been due to the fact that the test items themselves were not studied.

In addition to these studies, the relevance of opportunity to learn to student gain has been supported by the work of Brophy and Evertson (1973). These researchers report that in general successful teachers are those who have good management techniques and are well-organized so that they maximize student learning opportunities. The importance of this variable has been pointed out by the California Beginning Teacher Evaluation Study (Berliner, 1974). The proposal for Phase II of this project includes plans for the reexamination of preliminary findings which show promising relationships between teacher and student performance, to determine the extent to which the instruments used to measure student outcomes evaluated skills and knowledge that were part of the school curriculum.

These reports, as well as the logical appeal of student opportunity to learn as a predictor of achievement, provided the impetus for the present investigation.

## Procedure

The Evaluation of Teaching Project (EOTP) was funded by the National Institute of Education to explore methodological issues and problems relevant to teacher behavior research. Data for this investigation were collected by the EOTP in the Austin Independent School District (AISD), Austin, Texas, during the fall of 1974 and spring of 1975 in 32 predominantly middle-class fifth-grade classrooms. Pupil achievement data from approximately 950 students were collected before and after instruction in math and social studies. These data were collected utilizing instruments containing several

subscales with items keyed to an AISD curriculum guide. Teacher classroom behavior was quantified utilizing the Global Rating Scales, a project-designed high-inference instrument, and the Teacher Practices Observation Record (Brown, 1968), a low-inference classroom coding system. Data were also obtained on pupil attitudes toward their teachers and the content taught. In addition, an Opportunity to Learn Questionnaire designed to determine the extent to which curriculum objectives had been covered was completed by the teachers for each of their classes. Since the data from the Teacher Practices Observation Record and pupil attitudinal measures were not employed in the present investigation they will not be described here. More detailed descriptions of the sample selection process, data collection procedures, and the instruments used can be found in Poynor and Wetherold (1976) and Wetherold and Poynor (1976).

## Instruments

Student opportunity to learn was measured with a teacher questionnaire completed at posttest time. On this form, teachers indicated with check marks the curriculum objectives they had taught each student between the pre- and posttests given for each subject. The curriculum objectives for math covered six content areas: (1) Basic multiplication; (2) Factors and prime numbers; (3) Basic division; (4) Basic fractions; (5) Measurement (time, weight, etc.,); and (6) Geometry. These content areas corresponded to the subscales of the math achievement test. Social studies classes covered two units, Culture and Environment, during the school year. The social studies-Culture curriculum topics consisted of the following: (1) People inherit physical traits and learn cultural traits; (2) Differences in human behavior are learned, not inherited; (3) Natural environment influences culture; and (4) As people of different cultures interact, cultural

forms are modified. The curriculum topics for social studies-Environment were: (1) America's natural environment before colonization was one of unspoiled beauty; (2) The desire for natural resources caused some people to move westward; (3) Cultural beliefs influence people's use of the natural environment; and (4) In satisfying their wants and needs, people have sometimes abused the natural environment. Again, these objectives corresponded to the subscales of the social studies achievement tests. In addition to opportunity to learn information, teachers who ability grouped their classes were requested to indicate each student's ability level as "high," "medium," "low," or "special student."

All student achievement measures for the EOTP were constructed in a criterion-referenced fashion. That is, all items were generated directly from the AISD curriculum guide for fifth grade teachers. School district curriculum specialists were consulted in order to identify from the curriculum guide those content areas and specific objectives in mathematics and social studies most likely to be included in instruction during the data collection periods. For each of the areas and objectives identified, multiple-choice item pools were generated. After tentative items had been selected and refined within the project staff, a fifth-grade teacher was employed as a consultant for the final revision stage on all achievement measures, with the exception of the spring math measure (referred to as Math II in Poynor and Wetherold, 1976).

As indicated previously, achievement in both mathematics and social studies were of interest in the present investigation. The instrument employed to measure math achievement consisted of 33 multiple-choice items measuring student learning in the six math content areas given above, which were covered during the spring semester. Scoring of the pre- and post-administration of this instrument was accomplished by first dividing the students into

two groups, those who were judged by their teachers to have had the opportunity to learn the material on the posttest relevant to the individual subscales, and those judged to have had no opportunity to learn the material. Right-wrong scoring of each item was followed by summing the number of correct items per subscale to obtain subscale scores for each pupil who had both pre- and posttest data. In addition to the individual scores, pretest and posttest means for each classroom were calculated for use in the analyses in which teacher was the unit of analysis. Descriptive statistics for the Math II achievement test are presented in Tables 1 and 2, for classroom scores and individual student scores, respectively.

Since social studies classes covered two units during the school year, and the teachers could select the time they preferred to teach a particular unit, the unit tests were administered at various times throughout the fall and spring semesters. The Culture unit test consisted of 30 multiple-choice items designed to assess Culture vocabulary, facts, and ideas, for each of the four subscales listed above. Scoring for this test was the same as that for the math achievement test.

Student achievement on the four curriculum-based subscales for the social studies-Environment unit was measured with a 30-item multiple-choice instrument of the same format as the Culture unit test. Scoring of this instrument was identical to the procedures followed for the math and Culture tests. Descriptive statistics for the Environment and Culture tests are provided in Tables 3 through 6.

The Global Rating Scales (GRS) instrument is a high-inference, global rating observation system designed to identify and quantify those teacher classroom behaviors indicated by previous research to be correlated with pupil gain. The instrument was developed by the EOTP staff based on a

review of research studies (in Rosenshine, 1971) relating teacher behavior to pupil achievement. The version of the GRS employed in this study contained 11 one-item scales which are shown in Figure 1. Data for the GRS were collected during three observation periods for math instruction and during three observation periods of social studies classes for both Culture and Environment units. These data were prepared for analysis by obtaining the mean of each GRS scale for each teacher. For the GRS data collected during math instruction, the variance of each scale was also obtained for use in subsequent analyses.

Training procedures for the classroom observers using the GRS are reported in Poynor and Wetherold (1976). Two separate reliability checks indicated 76.6 and 70.1 average percent agreement of the coders with an expert after viewing two 20-minute segments of video taped lessons.

## Statistical Procedure

The primary question of interest in the present investigation was whether students who were rated as having had an opportunity to learn the material on the posttest differed in achievement from those students who did not have an opportunity to learn. Beyond that, it was our intent to examine the portions of variance in achievement which could be attributed to various independent variables, such as characteristics of teacher behavior, or ability-grouping. The method employed to test the hypotheses derived from these questions was multiple linear regression. With this approach, estimates of population values are given by the numerical values of weighting coefficients produced by a particular linear model. Full or starting models are developed which contain all the predictor variables under consideration. Restrictions implied by the null hypothesis are imposed upon the full model to produce a restricted model, with its own

estimates of population values. Comparisons of the estimated values produced by the full and restricted models are then made to determine if statistically significant information is lost by the imposition of the restrictions. The decision to reject or fail to reject the null hypothesis is made on the basis of an F statistic of the following form:

$$F = \frac{(RSF - RSR)/df_1}{(1-RSF)df_2}$$

where RSF = the proportion of observed criterion variance accounted for by the full model;

RSR = the proportion of observed criterion variance accounted for by the restricted model;

$df_1$ = a number representing the difference between the number of linearly independent predictor vectors in the full model and the number of linearly independent predictor vectors in the restricted model;

$df_2$ = a number representing the number of observations minus the number of linearly independent predictor vectors in the full model.

The value of the F statistic is associated with a probability value which can be used to decide if the restrictions placed on the full model result in a poorer representation of the data. If the probability value is higher than a preselected value of alpha ($\alpha$), then the restricted model represents the data as well as the full model and may be adopted as a full model in testing further restrictions.

The analyses for this investigation were conducted using an adapted version of a multiple regression program written by Jennings (see Ward and Jennings, 1973). An alpha value of .05 was chosen for rejecting null hypotheses.

The reporting of analyses and results will proceed according to the natural language questions posed for the analysis sets.

Is student achievement in math and social studies the same for students who have and have not had an opportunity to learn the material?

A series of regression analyses was performed to explore the possibility that level of achievement may differ for students who have or have not had an opportunity to learn the material on the posttest. The basic model utilized in these regression analyses contained either posttest math, Culture, or Environment subscales as criteria, and either pretest math, Culture, or Environment subscales and binary vectors representing opportunity to learn data as predictors. This type of model can be recognized as a covariance model in which the relationships of opportunity to learn and interaction between pretest and opportunity to learn to posttest achievement can be examined. Since the question of interest involved differences in achievement among students, individual student scores were utilized as the unit of analysis.

The full model (Model 1) employed in each analysis sequence was as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + e_1$$

where

$Y$ = Posttest subscale scores

$a_0$ = the regression constant

$a_1$ = the regression coefficient for $X_1$

$X_1$ = a binary vector containing a 1 for each student judged to have had an opportunity to learn, 0 otherwise

$a_2$ = the regression coefficient for $X_2$

$X_2$ = a binary vector containing a 1 for each student with no opportunity to learn, 0 otherwise

$a_3$ = the regression coefficient for $X_3$

$X_3$ = a vector containing pretest scores for those students with opportunity to learn, 0 otherwise

$a_4$ = the regression coefficient for $X_4$

$X_4$ = a vector containing pretest scores for those students with no opportunity to learn, 0 otherwise

$e_1$ = the residual vector

Model 2 imposed the restriction that differences between the opportunity to learn group (OTL) and the no opportunity to learn group (NOTL) are the same regardless of pretest scores, i.e., that differences are not a function of pretest scores. In this model a common slope is forced for the regression of posttest on pretest for the two groups. The F-tests associated with the comparisons of Models 1 and 2 served as tests for the presence of groups by pretest interaction. Model 2 was as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_5 + e_2$$

where the notation is as in Model 1, except for $X_5$, which is a vector containing the pretest scores for all students. Although the same symbols are used to represent the weighting coefficients in the restricted models, it is important to note that they can represent different numerical values than the identical symbols in the full models.

Results of the comparisons of Models 1 and 2 are summarized in Tables 7 through 9, for math, social studies-Culture, and social studies-Environment, respectively. Significant differences were obtained for subscale 3 for math (Basic Division), and subscale 4 for Culture (Interaction among Cultures). Estimates of the expected values for Model 1 are depicted graphically in Figures 2 and 3, for the subscales found to have a significant groups by pretest interaction.

From the graph for math subscale 3, it can be seen that as pretest scores increase, the predicted difference on the posttest between the OTL

and NOTL increases. In other words, the effect of opportunity to learn is greater for the higher pretest scores. The Culture, subscale 4 results indicate that opportunity to learn again has a greater effect as pretest scores increase, with larger predicted differences on the posttest between OTL and NOTL groups appearing at the high end of the pretest scale. However, the interaction evidenced by the Culture, subscale 4 data is disordinal, i.e., the group regressions intersect within the observed range of test values, while that for math, subscale 3 is ordinal -- group regressions d not intersect within the observed range of values.

Tests for regions of significance were conducted on these subscale results, utilizing a computer program following the formulas set out by Johnson and Neyman (1936) (see Borich, Godbout, and Wunderlich, 1976). A region of significance describes a range of values of a predictor variable for which there are significant group differences on the criterion -- that is, the separation of the regression lines is significantly different from zero. For math subscale 3, the region of significance begin at .5799 on the pretest scale and extends to the upper limit of the observed pretest values. The lower bound of this region is indicated in Figure 2 by the vertical line extending upward from .5799 on the abscissa.

For the Culture, subscale 4 results the test for regions of significance indicated two areas with significant differences. At the lower end of the pretest scores, significant differences between OTL and NOTL groups were found between pretest values of zero and 1.00. A vertical line in Figure 3 erected at 1.00 on the abscissa indicates the upper boundary for this left region of significance. The second region of significance begins at the pretest value of 3.37 and extends outward to the maximum observed pretest value of 8.00, indicating significant differences in achievement between the OTL and NOTL groups for these pretest values. The lower limit of this

region is indicated by a vertical line erected at 3.37 on the abscissa in Figure 3.

For the subscales which did not show significant interaction, Model 2 was adopted as the new full model and a second series of model comparisons was undertaken. Model 3, the next restricted model, was of the following form:

$$Y = a_0 + a_1 X_5 + e_3$$

where the notation is the same as given previously. Comparisons between Models 2 and 3 test whether the differences in achievement between OTL and NOTL groups are equal to zero. Results of the F-tests over all subscales for math, Culture, and Environment are presented in Tables 10 through 12, respectively. As indicated in the tables, significant differences between adjusted means for the OTL and NOTL groups were obtained for four of the five math subscales, for none of the three Culture subscales, and for one of the four Environment subscales. In each case, the students who had the opportunity to learn the material on the posttest had higher adjusted mean scores than the students having no opportunity to learn the material.

Are the relationships between teacher behaviors and student achievement in math the same for high, medium, and low pupil ability groups, all of whom had an opportunity to learn the material?

In order to answer this question, a series of regression analyses was conducted using the teacher, or classroom, as the unit of analysis. Classroom mean scores were computed for those students claimed by the teacher to have been taught the curricula objectives corresponding to the subscales on the test. Mean posttest scores were used as the criterion; predictor information consisted of mean pretest scores, and the mean ratings for the teachers on the Global Rating Scale. This series of tests was performed on the math data only, as there were too few students ability-grouped in social studies to make the analyses feasible.

The starting model consisted of:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_1X_4 + a_5X_2X_4 + a_6X_3X_4 + a_7X_1X_5$$
$$a_8X_2X_5 + a_9X_3X_5 + e_1$$

where

$Y$ = a vector containing within-classroom ability-group mean posttest subscale scores

$a_0$ = the regression constant

$a_1$ = the regression coefficient for $X_1$

$X_1$ = a binary vector containing a 1 for high ability groups, 0 otherwise

$a_2$ = the regression coefficient for $X_2$

$X_2$ = a binary vector containing a 1 for medium ability groups, 0 otherwise

$a_3$ = the regression coefficient for $X_3$

$X_3$ = a binary vector containing a 1 for low ability groups, 0 otherwise

$a_4$ = the regression coefficient for the product vector $X_1X_4$

$X_4$ = a vector containing within-classroom ability-group mean pretest subscale scores

$a_5$ = the regression coefficient for the product vector $X_2X_4$

$a_6$ = the regression coefficient for the product vector $X_3X_4$

$a_7$ = the regression coefficient for the product vector $X_1X_5$

$X_5$ = a vector containing mean scores for teachers on one of the 11 GRS scales

$a_8$ = the regression coefficient for the product vector $X_2X_5$

$a_9$ = the regression coefficient for the product vector $X_3X_5$

$e_1$ = the residual vector

The predictor variables in this model which contain a pair of X terms indicate that those independent variables are composed of the product of the X terms designated. The regression weights for these product terms reflect the variance in achievement accounted for by the joint contribution or interaction of the terms occurring in the product.

The first restricted model (Model 2) forced a common slope for the regression of posttest on GRS for the three ability groups. The F-tests associated with the comparisons of Models 1 and 2 test for an interaction of teacher behavior as measured by the GRS with ability grouping. Model 2 consisted of:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_1X_4 + a_5X_2X_4 + a_6X_3X_4 + a_7X_5 + e_2$$

where the elements are defined as given above.

Models 1 and 2 were compared across all of the six math subscales, with each of the 11 GRS variables used successively in the predictor set. Results of comparisons of Models 1 and 2 are presented in Tables 13 through 18. As shown in the tables, only three of the 66 comparisons were statistically significant. Since this number was not greater than that expected by chance, Model 2 was adopted as the full model for the next series of tests. Using the same definitions given above, Model 3 was as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + e_3$$

This model forced common group regression slopes across ability groups for posttest on pretest. Comparisons of Models 2 and 3 test for an interaction of ability group membership with pretest scores. Results of these comparisons are presented in Tables 19 through 24. No evidence for a group by pretest interaction was observed, since none of the obtained F-ratios was statistically significant.

This series of analyses extended the investigation by Poynor, Calkins, and Kugle (1976) of the effects of classroom contextual variables on process-product relationships. Whereas Poynor, et al., considered all students who were ability-grouped, the present report dealt only with those students who were rated as having an opportunity to learn the material on the posttest. As in the previous investigation, the present study found no evidence that the slopes of the relationships between teacher behavior and pupil achievement differed for high, medium, and low pupil ability subgroups.

Is teacher behavior related to social studies achievement for pupils who have had an opportunity to learn the material?

In order to answer this question, a series of regression analyses similar to that previously described was carried out. Identical sets of models and model comparisons were computed across Culture and Environment subscales with each of the 11 GRS scales, in turn, included in the predictor set. Again, since teacher behavior was the focus of inquiry in this section, classroom was utilized as the unit of analysis. The starting model utilized for this analysis series was:

$$Y = a_0 + a_1X_1 + a_2X_2 + e_1$$

where

$Y$ = the criterion variable (classroom mean posttest scores for those students judged to have had an opportunity to learn the material tested)

$a_0$ = the regression constant

$a_1$ = the regression coefficient for $X_1$

$X_1$ = a vector containing classroom mean pretest scores for the OTL group

$a_2$ = the regression coefficient for $X_2$

$X_2$ = a vector containing teacher mean scores for one of the 11 GRS scales

$e_1$ = the residual vector

The values of the coefficients $a_1$ and $a_2$ in the starting model are a function of the amount of change in performance accounted for by the observed teacher behavior.

The restricted model employed was:

$$Y = a_0 + a_1X_1 + e_2$$

where the notation is as in Model 1. This restriction tests the contribution of teacher behavior as measured by the GRS variables to posttest achievement for those students who had an opportunity to learn the content taught. The analyses were conducted for each subscale of the Culture and Environment tests, over each of the 11 subscales of the GRS. Total scores were not analyzed since the particular students who had the opportunity to learn the material differed from subtest to subtest. These same analyses were performed on the math data as part of a larger series of tests and are treated in the next section of this report.

The results of these analyses are presented in Tables 25 through 32. In one of 44 analyses conducted on the Culture data, GRS means are significantly related to posttest achievement and in two of 44 analyses conducted on the Environment data, GRS means are significantly related to posttest achievement. Given that the number of statistically significantly relationships is low, these results will be interpreted as Type I errors. For 44 analyses where $\alpha = .05$, about two ($.05 \times 44$) Type I errors are expected; neither set of the observed significant relationships exceeded the expected number. Hence, these analyses failed to discover any relationships between teacher behavior as measured by the GRS and student achievement in social studies for those students who had an opportunity to learn the material on the posttest.

What is the nature of the relationships between pupil achievement in math and characteristics of observed teacher behavior distributions for those students who have had an opportunity to learn?

This set of analyses is a part of a series of tests which extended the investigation of Calkins, Godbout, Poynor, and Kugle (1976) into the effects on posttest performance of information inherent in the distribution of teacher process variables. Specifically, the contributions of the GRS mean scores, GRS mean scores squared, GRS variance, and GRS variance squared to the prediction of math achievement were examined. The starting model (Model 1) for this series of analyses was as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + e_1$$

where

Y = math posttest classroom mean scores for students who had an opportunity to learn

$a_0$ = the regression constant

$a_1$ = the regression coefficient for $X_1$

$X_1$ = a vector containing math pretest classroom mean scores for students who had the opportunity to learn

$a_2$ = the regression coefficient for $X_2$

$X_2$ = a vector containing teacher mean scores on one of the 11 GRS scales

$a_3$ = the regression coefficient for $X_3$

$X_3$ = a vector containing teacher mean scores squared on one of the 11 GRS scales

$a_4$ = the regression coefficient for $X_4$

$X_4$ = a vector containing teacher variance scores on one of the 11 GRS scales

$a_5$ = the regression coefficient for $X_5$

$X_5$ = a vector containing teacher variance scores squared on one of the 11 GRS scales

$e_1$ = the residual vector

The coefficients $a_2$ through $a_5$ in this starting model are a function of the amount of change in performance accounted for by the characteristics of the distributions of the observed teacher behavior. Null hypotheses that $a_2$ through $a_5$ are equal to zero for the population were tested utilizing a backward elimination procedure. In this procedure, the null hypothesis that $a_5$ equals zero was tested utilizing Model 1 as a full model and restricting $a_5$ to zero. Null hypotheses involving $a_4$ were tested utilizing a full model in which $a_4$ and $a_5$ were zero; and null hypotheses involving $a_2$ were tested utilizing a full model in which $a_3$, $a_4$, and $a_5$ were zero.

The results of these analyses are presented in Tables 33 through 44. Only a small number of the GRS variables accounted for a significant amount of variance in math achievement. In five of 66 analyses conducted, GRS means were significantly related to posttest achievement; in two of 66 analyses, GRS means squared were significantly related to posttest achievement; in three of 66 analyses GRS variances were significantly related to posttest achievement; and in three of 66 analyses GRS variances squared were significantly related to posttest achievement. These results will again be interpreted as Type I errors: for 66 analyses where $\alpha = .05$, about three (.05 X 66) Type I errors are expected. Thus only for the GRS means are the observed number of significant relationships greater than that expected by chance.

Further, if the results of the 66 tests of null hypotheses for the math scales are considered to be samples from populations in which the null hypothesis is true for every member, it can be seen that the number of

significant relationships will vary as a result of chance (Godbout, 1975). If a confidence band extending above the expected number of chance significant results is established, then a comparison of the upper limit of this interval with the obtained results would be helpful in deciding whether all the observed significant relationships are Type I errors.

Utilizing the binomial distribution with $p = .05$ and $q = .95$, the upper limit of the 95% confidence band for samples of size 66 is seven. Since the number of significant relationships for the math scales is five, it is difficult to conclude that the results are different than would be obtained on the basis of chance. Hence, this series of analyses failed to discover any relationships between pupil achievement in math and characteristics of observed teacher behavior distributions for those students who had an opportunity to learn the material on the posttest.

## Discussion

The present investigation represents an attempt to examine student opportunity to learn as a variable which contributes to the prediction of pupil achievement. In this context, it was our intent to examine: (1) whether students who had an opportunity to learn the material differ in posttest achievement from those students who did not have an opportunity to learn: (2) whether the relationships between teacher behaviors and student achievement in math differ for different pupil ability-groups; (3) whether teacher behavior is related to student achievement in social studies for students who had an opportunity to learn; and, (4) whether the statistical characteristics of teacher behavior distributions are related to pupil achievement for students with opportunity to learn. The discussion of the results of the analyses conducted to explore these questions will follow in the order noted above.

The primary intent of the present study was to determine whether students who had an opportunity to learn the material corresponding to subscales of post-instruction tests differed in achievement from those students who did not have an opportunity to learn the material. The pupil achievement measures utilized were pre- and posttest scores on two four-scale social studies tests (Culture and Environment), and one six-scale mathematics test. Student opportunity to learn was determined by teachers' ratings of the individual students whe were taught the curriculum objectives corresponding to the subscales of the tests. An analysis of covariance, using pretest as the covariate, was utilized to test first for significant differences between the slopes of the regression lines for the opportunity to learn (OTL) group and the no opportunity to learn (NOTL) group, and second for significant differences between adjusted

means for the two groups.

For the math data, significant differences in adjusted means between the OTL and NOTL groups were obtained on four out of five subscales. In each case, the students who had the opportunity to learn the material on the posttest had higher adjusted mean scores than the students having no opportunity to learn. In addition, a significant interaction between pretest score and opportunity to learn was observed for subscale 3, with differences between the OTL and NOTL groups increasing as pretest score increases. The interaction was ordinal, i.e., the students who had an opportunity to learn had higher predicted posttest scores than the students who had no opportunity to learn, across all values of the pretest scale. Thus for the five math subscales for which significant results were observed, the conclusions to be drawn are essentially the same: the students who had an opportunity to learn the material were superior to those having no opportunity to learn in terms of posttest achievement in mathematics.

The results of the social studies analyses yielded significant differences between adjusted means for the two groups on only one out of the four Environment subscales, and no significant differences between adjusted means for the two groups on the Culture subscales. One disordinal significant interaction between opportunity to learn and pretest score was observed for the Culture, subscale 4 data. Two regions of significance were found for this interaction: at the lower end of the pretest scale the NOTL group had significantly higher predicted posttest scores than the OTL group, and at the higher end of the pretest scale the OTL group had significantly higher predicted posttest scores than the NOTL group. Thus, the conclusions which can be drawn from the results

of the social studies analyses differ from those of the math analyses: it was not shown for all observed pretest scores that students who had an opportunity to learn the material were superior to those having no opportunity to learn.

It is possible that the differences between the math and social studies results are due to the nature of the content covered in these two subject areas. The concepts learned in math are highly specific and it is probable that students not exposed to them would have difficulty in deducing the correct answers on the posttest. The concepts covered in social studies are more general and could be more easily obtained from sources outside the classroom, hence the failure to find many significant findings between OTL and NOTL for social studies. The generality of responses required on the social studies posttest might allow differences between opportunity to learn (in class) and no opportunity to learn (in class) to be masked.

The interaction between pretest and opportunity to learn observed for Culture, subscale 4 is somewhat counter to expectation, given that the predicted posttest scores for the NOTL group at the low end of the pretest scale are significantly higher than those for students given an opportunity to learn the material. Although this interaction is intriguing, it requires replication to provide confidence that it is not a chance finding.

It should be noted that a potential source of invalidity in the present investigation exists in the instrumentation utilized to quantify student achievement and opportunity to learn. In spite of the measures taken by the Evaluation of Teaching Project staff to ensure that achievement tests were curriculum-based, the possibility exists that teachers deviated from the math and social studies objectives in their classroom presentations. The tests were prepared prior to any actual lessons and were based on objectives <u>likely</u> to be covered during the semester; the guidelines allowed flexibility on the

part of the teachers to change lesson content if they so desired.

Student opportunity to learn was assessed by teacher ratings designating those individual students who were believed to have had an opportunity to learn the objectives corresponding to the test subscales. Since these ratings were completed at posttest time, the teachers' reliance on memory regarding which students were present during any particular instructional sequence must necessarily contain some degree of unreliability. For future research more reliable measures of opportunity to learn might include amount of time actually spent in class by the pupil, or amount of time actually spent on a particular topic by the teacher. Both of these measures could be taken by an observer who could also obtain the attendance roster for each observation period, thus eliminating the potential source of unreliability inherent in teacher ratings.

The second major focus of inquiry in the present investigation was concerned with the discovery of relationships between teacher behavior and pupil achievement for those students who had an opportunity to learn the material. Previous attempts by the Evaluation of Teaching Project staff (Calkins, et al., 1976; Poynor, et al., 1976) to explore the nature of these relationships have resulted in a lack of significant findings. The present study replicated the previous EOTP analyses for only those students rated as having had an opportunity to learn the material tested. Classroom mean scores on math and social studies pre- and posttests were utilized as pupil achievement measures. Teacher behavior was quantified with the Global Rating Scales (GRS) instrument, composed of 11 one-item scales descriptive of those teacher classroom behavior indicated by previous research to be correlated with pupil gain. The data were analyzed using linear regression models which allowed an examination of the portions of variance in achievement which could be attributed to the various independent variables of interest.

Three series of analyses were conducted to explore the nature of the relationships between teacher behavior and pupil achievement for those students who had an opportunity to learn. The first of these examined the relationships between teacher behavior and pupil achievement in mathematics for high, medium, and low pupil ability groups. The second series of analyses examined the contribution of teacher behavior to pupil achievement in social studies. The third analyses series explored the contributions of characteristics of observed teacher behavior distributions to the prediction of math achievement. The results of all three of these analyses sets indicated that only a small number of the independent variables examined accounted for a significant amount of variance in pupil achievement. In fact, the number of these significant results is probably within the boundaries of what is expected on the basis of chance.

This outcome is somewhat discouraging, given the prevelant idea that teacher behavior does make a difference in pupil achievement. There are several possible conclusions to be drawn from this lack of significant findings. One possibility is that teacher behavior is not related to student achievement. Another is that teacher behavior is related to pupil achievement, but the effect is small compared to other, more potent factors such as the socioeconomic status and family background of the pupil. It is possible that teacher behavior accounts for so little variance in pupil achievement that our methods of analyses are not appropriate for the discovery of such relationships. Finally, it may be that the specific teacher behaviors utilized in the present study were not the ones which make a difference in pupil achievement. Subsequent studies in the Evaluation of Teaching Project will attempt to address these alternative hypotheses.

FIGURE 1

DESCRIPTIONS OF THE 11 SCALES OF THE GLOBAL RATING SCALES

(1) Criticism (personal-general)--Criticism, as defined for this instrument, refers to the verbal and nonverbal behaviors a teacher uses in finding fault with and attempting to correct student cognitive processes and/or behavior. A personal style of criticism is characterized as being directed toward a specific individual or toward a discrete and easily identified small group. General criticism is directed toward the class in general or toward a group addressed collectively, with the identity of individuals being observed and subsumed within the class or group.

(2) Criticism (kind-harsh)--Kind teacher criticism is defined as being supportive and considerate, achieving a positive effect. Harsh criticism has undertones of hostility, anger, and/or ridicule, producing a negative effect.

(3) Warmth (warm-cold)--A warm teacher is defined as considerate, kind, friendly, and humanistic, while a cold teacher is one who maintains a distance between herself/himself and the students, and who demonstrates little personal interest in students outside the teaching role.

(4) Enthusiasm (enthusiastic-apathetic)--An enthusiastic teacher demonstrates interest in the subject matter, the learning process, and student involvement in that process. On the other end of the scale, the apathetic teacher appears uninterested and uninvolved.

(5) Environment (supportive-unsupportive)--This rating of classroom environment is based on a teacher's creation and use of the teaching/learning environment. In a supportive environment, the physical setting reinforces learning through relevant displays, flexible seating arrangements, and incorporation of students' contributions. An unsupportive environment is one which fails to include the above factors to create a favorable, stimulating learning situation.

(6) Task (focused-unfocused)--On this scale, the degree to which a teacher works toward learning objectives in lesson presentation and in supervision of student work period is placed on a continuum from focused to unfocused. Focused task orientation is characterized by well-planned and well-paced class activities, focused discussion periods, and efficient procedural activities. Unfocused task orientation is evident in wandering discussions, disorganized presentation of lesson content, lengthy procedures, and unproductive class activity.

(7) Clarity (understood-ambiguous)--Here, teacher clarity refers to a teacher's ability to communicate at the students' level of comprehension. Indicators that a teacher is understood by students are found in student reactions to the teacher as well as in the teacher's behavior. An "understood" rating applies to a teacher who provides examples and whose students react to lesson presentation and teacher instructions with behavior indicating their comprehension. Other than the absence of the above characteristics of teacher clarity, indicators of ambiguity are students' bewilderment, repetitious questions and frequent incorrect responses, along with vague or evasive teacher responses.

FIGURE 1

(8) Structuring (organized-disorganized)--A teacher evidences organized structuring of content with smooth, well-planned lesson presentation and classroom activities, and by including introductory comments, summaries and reviews. Disorganized structuring is indicated by disorganized presentation of material and by classroom activities in which learning objectives are not apparent.

(9) Cognitive variation (varied-static)--This scale reflects the degree to which a teacher varies instructional modes to achieve a variety of cognitive processes in the classroom.

(10) Variety of methods (high-low)--This scale reflects the degree to which a teacher varies instructional modes.

(11) Cognitive variety (high-low)--This scale indicates the degree to which a teacher facilitates movement from one cognitive level to another by varying types of questions and activities.

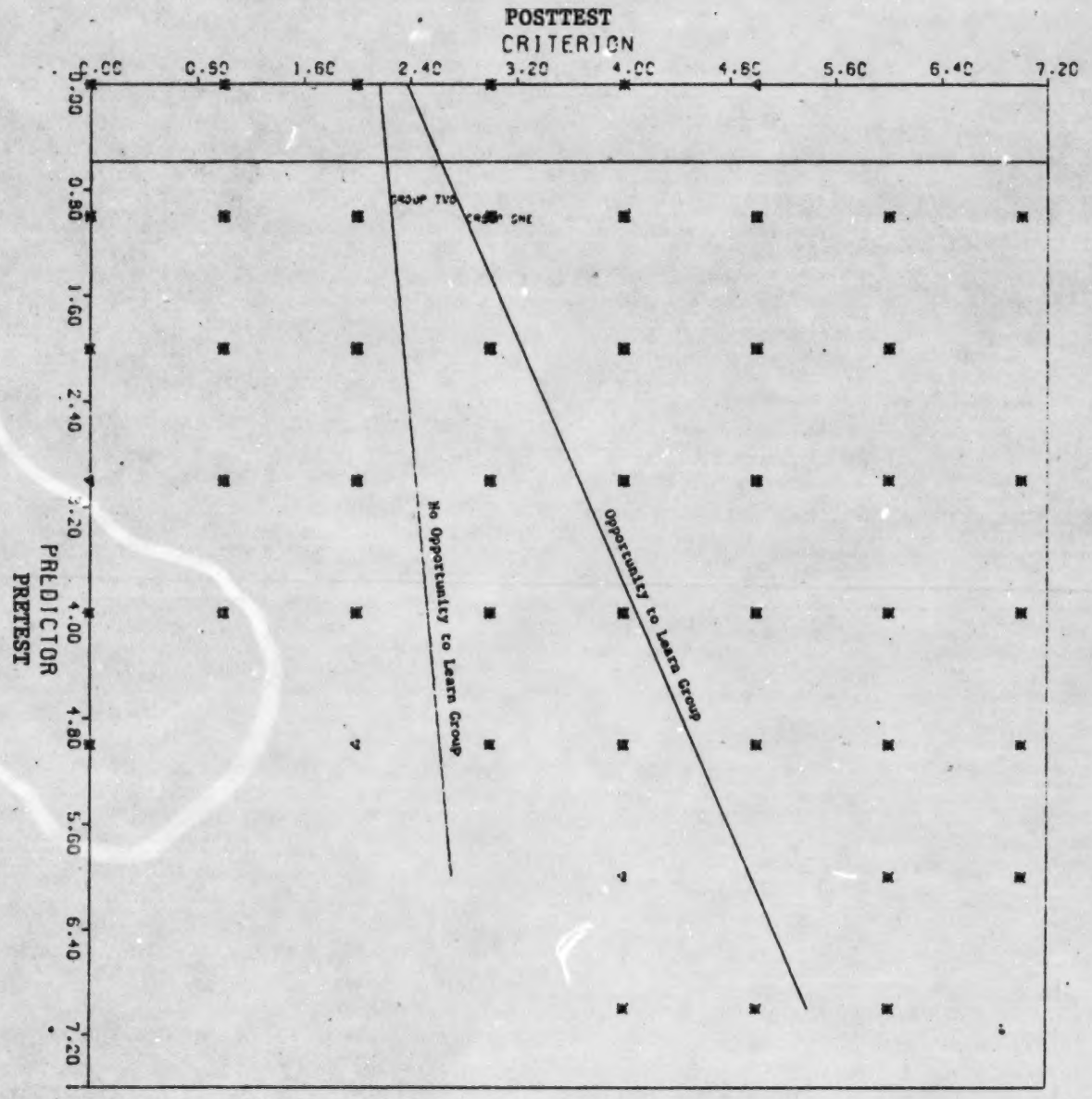


FIGURE 2

ESTIMATES OF THE EXPECTED VALUES FOR MODEL 1, SHOWING REGIONS OF SIGNIFICANT DIFFERENCES BETWEEN OPPORTUNITY TO LEARN AND NO OPPORTUNITY TO LEARN GROUPS FOR MATH, SUBSCALE 3.

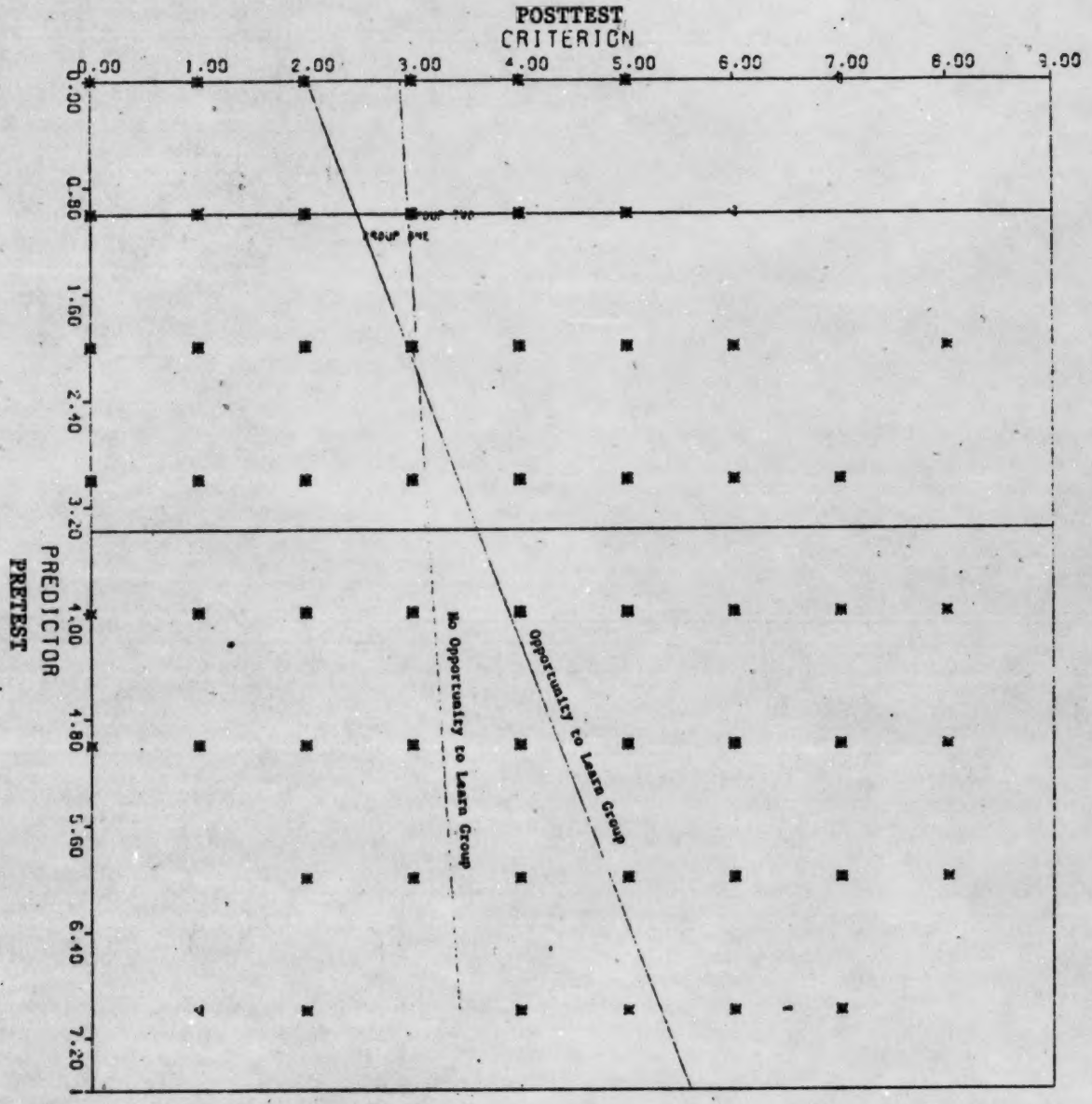


FIGURE 3

ESTIMATES OF THE EXPECTED VALUES FOR MODEL 1, SHOWING REGIONS OF SIGNIFICANT DIFFERENCES BETWEEN OPPORTUNITY TO LEARN AND NO OPPORTUNITY TO LEARN GROUPS FOR CULTURE, SUBSCALE 4.

Table 1

Math Pre- and Posttest Means, Standard Deviations, and Alpha Reliability Coefficients for Subscales and Total Scale, Computed from Classroom Item Means (N = 32 Classrooms Totaling 607 Students)

| | | Basic Multiplication | | Factors and Prime Numbers | | Basic Division | | Basic Fractions | | Measurement, (Time, Weight, Etc.) | | Geometry | | Total Scale | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | | 5 | 5 | 4 | 4 | 7 | 7 | 3 | 3 | 5 | 5 | 9 | 9 | 33 | 33 |
| Subscale $\bar{X}$ | | 2.69 | 3.30 | 1.03 | 1.50 | 2.28 | 2.99 | .87 | 1.22 | 3.06 | 3.52 | 3.41 | 4.22 | 13.33 | 16.75 |
| Subscale S.D. | | .78 | .54 | .30 | .49 | .54 | .78 | .21 | .48 | .39 | .40 | .91 | .78 | 2.41 | 2.93 |
| Alpha Coefficient | | .86 | .78 | .24 | .70 | .55 | .79 | .00 | .80 | .61 | .58 | .83 | .76 | .89 | .93 |
| Range | Low | .78 | 2.11 | .52 | .27 | 1.21 | 1.67 | .50 | .57 | 1.88 | 2.42 | 1.56 | 2.83 | 9.69 | 11.84 |
| | High | 4.27 | 4.20 | 1.91 | 2.36 | 3.33 | 4.64 | 1.38 | 2.11 | 3.86 | 4.50 | 5.09 | 5.67 | 17.62 | 22.09 |

Table 2

Math II Pre- and Posttest Means and Standard Deviations for Subscales, Computed from Student Scores (Total N = 603)

| | Basic Multiplication | | Factors and Prime Numbers | | Basic Division | | Basic Fractions | | Measurement | | Geometry | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | 5 | 5 | 4 | 4 | 7 | 7 | 3 | 3 | 5 | 5 | 9 | 9 |
| OTL: | | | | | | | | | | | | |
| Subscale $\bar{X}$ | 2.72 | 3.36 | 1.07 | 1.58 | 2.44 | 3.42 | .94 | 1.55 | 3.15 | 3.71 | 4.02 | 4.60 |
| Subscale S.D. | 1.46 | 1.30 | .90 | 1.03 | 1.36 | 1.65 | .85 | .99 | 1.17 | .91 | 1.88 | 1.63 |
| N | 594 | 594 | 580 | 580 | 425 | 425 | 403 | 403 | 291 | 291 | 324 | 324 |
| NOTL: | | | | | | | | | | | | |
| Subscale $\bar{X}$ | 1.44 | 1.56 | .70 | 1.09 | 2.01 | 2.35 | .79 | .79 | 3.05 | 3.34 | 2.96 | 3.83 |
| Subscale S.D. | 1.50 | 1.17 | .91 | .83 | 1.29 | 1.34 | .75 | .70 | 1.11 | 1.02 | 1.73 | 1.56 |
| N | 9 | 9 | 23 | 23 | 178 | 178 | 200 | 200 | 312 | 312 | 279 | 279 |



OTL - Students who had an opportunity to learn

NOTL - Students who had no opportunity to learn

Table 4

Social Studies Environment Pre- and Posttest Means, Standard Deviations, and Alpha Reliability Coefficients for Subscales and Total Scale, Computed from Classroom Item Means (N = 32 Classrooms Totaling 614 Students)

| | America's Natural Beauty | | Westward Move | | Culture, Attitudes, and Environment | | Environmental Misuse | | Total Scale | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | 8 | 8 | 8 | 8 | 6 | 6 | 8 | 8 | 30 | 30 |
| Subscale $\overline{X}$ | 4.05 | 5.02 | 3.86 | 4.53 | 2.49 | 2.97 | 3.48 | 4.36 | 13.88 | 16.87 |
| Subscale S.D. | .74 | .73 | .70 | .73 | .55 | .51 | .64 | .58 | 2.32 | 2.36 |
| Alpha Coefficient | .79 | .79 | .77 | .79 | .64 | .68 | .72 | .57 | .92 | .92 |

Table 4

Social Studies - Environment Pre- and Posttest Means and Standard Deviations for Subscales, Computed from Student Scores (Total N = 614)

| | Subscale 1 | | Subscale 2 | | Subscale 3 | | Subscale 4 | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | 8 | 8 | 8 | 8 | 6 | 6 | 8 | 8 |
| OTL: | | | | | | | | |
| Subscale $\bar{X}$ | 3.97 | 5.00 | 3.97 | 4.73 | 2.49 | 3.02 | 3.54 | 4.42 |
| Subscale S.D. | 1.97 | 1.90 | 1.83 | 1.91 | 1.34 | 1.38 | 1.82 | 1.94 |
| N | 485 | 485 | 464 | 464 | 373 | 373 | 529 | 529 |
| NOTL: | | | | | | | | |
| Subscale $\bar{X}$ | 4.29 | 5.15 | 3.63 | 3.93 | 2.61 | 2.97 | 3.33 | 4.18 |
| Subscale S.D. | 1.91 | 1.90 | 1.88 | 1.88 | 1.49 | 1.52 | 1.82 | 1.97 |
| N | 129 | 129 | 150 | 150 | 241 | 241 | 85 | 85 |

OTL - Students who had an opportunity to learn
NOTL - Students who had no opportunity to learn



Subscale 1 - America's natural environment before colonization was one of unspoiled beauty
Subscale 2 - The desire for natural resources caused some people to move westward
Subscale 3 - Cultural beliefs influence men's use of the natural environment
Subscale 4 - In satisfying his wants and needs, man has sometimes abused the natural environment

Table 5

Social Studies Culture Pre- and Posttest Means, Standard Deviations, and Alpha Reliability Coefficients for Subscales and Total Scale, Computed from Classroom Item Means (N = 31 Classrooms Totaling 686 Students)

| | Physical and Cultural Traits | | Learning, Genetics, and Behavior | | Environment and Culture | | Interaction among Cultures | | Total Scale | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | 8 | 8 | 7 | 7 | 7 | 7 | 8 | 8 | 30 | 30 |
| Subscale $\overline{X}$ | 3.32 | 4.01 | 2.56 | 2.84 | 3.27 | 3.53 | 3.01 | 3.35 | 12.17 | 13.73 |
| Subscale S.D. | .64 | .59 | .33 | .42 | .62 | .62 | .47 | .60 | 1.55 | 1.91 |
| Alpha Coefficient | .70 | .63 | .21 | .46 | .72 | .75 | .58 | .72 | .82 | .88 |

Table 6

Social Studies - Culture Pre- and Posttest Means and Standard Deviations for Subscales, Computed from Student Scores (Total N = 687)

| | Subscale 1 | | Subscale 2 | | Subscale 3 | | Subscale 4 | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Number of Items | 8 | 8 | 7 | 7 | 7 | 7 | 8 | 8 |
| OTL: | | | | | | | | |
| Subscale $\bar{X}$ | 3.33 | 4.00 | 2.57 | 2.96 | 3.41 | 3.56 | 3.09 | 3.40 |
| Subscale S.D. | 1.72 | 1.87 | 1.38 | 1.38 | 1.67 | 1.74 | 1.74 | 1.82 |
| N | 606 | 606 | 325 | 325 | 540 | 540 | 587 | 587 |
| NOTL: | | | | | | | | |
| Subscale $\bar{X}$ | 3.11 | 4.04 | 2.59 | 2.79 | 2.97 | 3.48 | 2.68 | 3.10 |
| Subscale S.D. | 1.58 | 1.78 | 1.30 | 1.47 | 1.57 | 1.85 | 1.58 | 1.55 |
| N | 81 | 81 | 362 | 362 | 147 | 147 | 100 | 100 |

OTL - Students who had an opportunity to learn
NOTL - Students who had no opportunity to learn

Subscale 1 - People inherit physical traits and learn cultural traits
Subscale 2 - Differences in human behavior are learned, not inherited
Subscale 3 - Natural environment influences culture
Subscale 4 - As people of different cultures interact, cultural forms are modified

Table 7

Summary of Comparisons of Models 1 and 2 For Math: Hypothesis of Groups by Pretest Interaction

| Subscale | $R^2$ Full (Model 1) | $R^2$ Rest (Model 2) | $R^2$ Diff. (Model 1 - Model 2) | F* | P |
|---|---|---|---|---|---|
| 1. Basic Multiplication | .1953 | .1951 | .0001 | .1026 | .7489 |
| 2. Factors & Prime Numbers | .0591 | .0588 | .0003 | .1714 | .6790 |
| 3. Basic Division | .1817 | .1662 | .0155 | 11.3472 | .0008 |
| 4. Basic Fractions | .1752 | .1716 | .0036 | 2.5967 | .1076 |
| 5. Measurement | .1057 | .1042 | .0014 | .9660 | .3261 |
| 6. Geometry | .1940 | .1914 | .0026 | 1.9582 | .1622 |

*$df_1/df_2$ = 1/599

Table 8

Summary of Comparisons of Models 1 and 2 for Social Studies-Culture: Hypothesis of Groups by Pretest Interaction

| Subscale | $R^2$ Full (Model 1) | $R^2$ Rest (Model 2) | $R^2$ Diff. (Model 1 - Model 2) | F* | P |
|---|---|---|---|---|---|
| 1 - Physical and Cultural traits | .1909 | .1893 | .0015 | 1.3050 | .2537 |
| 2 - Learning Genetics and Behavior | .0540 | .0521 | .0019 | 1.3383 | .2477 |
| 3 - Environment and Culture | .3224 | .3199 | .0025 | 2.5369 | .1117 |
| 4 - Interaction Among Cultures | .1653 | .1517 | .0135 | 11.0801 | .0009 |

*$df_1/df_2$ = 1/683

Table 9

Summary of Comparisons of Models 1 and 2 for Social Studies - Environment: Hypothesis of Groups by Pretest Interaction

| Subscale | $R^2$ Full (Model 1) | $R^2$ Rest (Model 2) | $R^2$ Diff. (Model 1 - Model 2) | F* | P |
|---|---|---|---|---|---|
| 1 - America's Natural Beauty | .2317 | .2308 | .0009 | .7083 | .4003 |
| 2 - Westward Move | .2533 | .2533 | .0000 | .0020 | .9645 |
| 3 - Culture, Attitudes and Environment | .1932 | .1929 | .0003 | .2120 | .6454 |
| 4 - Environmental Misuse | .2092 | .2087 | .0005 | .3934 | .5307 |

*$df_1/df_2$ = 1/610

Table 10

Summary of Comparisons of Models 2 and 3 for Math:

Hypothesis that Opportunity to Learn Makes a Difference in Posttest Achievement

| Subscale | $R^2$ Full (Model 2) | $R^2$ Rest. (Model 3) | $R^2$ Diff. (Model 2- Model 3) | F* | P |
|---|---|---|---|---|---|
| 1 - Basic Multiplication | .1951 | .1802 | .0150 | 11.1598 | .0009 |
| 2 - Factors and Prime Numbers | .0588 | .0532 | .0056 | 3.5699 | .0593 |
| 4 - Basic Fractions | .1716 | .0506 | .1210 | 87.6250 | .0000 |
| 5 - Measurement | .1042 | .0732 | .0310 | 20.7612 | .0000 |
| 6 - Geometry | .1914 | .1771 | .0143 | 10.5885 | .0012 |

*df 1/df 2 = 1/600

Table 11

Summary of Comparisons of Models 2 and 3 for Social Studies-Culture:

Hypothesis that Opportunity to Learn Makes a Difference in Posttest Achievement

| Subscale | $R^2$ Full (Model 2) | $R^2$ Rest. (Model 3) | $R^2$ Diff. (Model 2- Model 3) | F* | P |
|---|---|---|---|---|---|
| 1 - Physical & Cultural Traits | .1893 | .1886 | .0008 | .6358 | .4255 |
| 2 - Learning, Genetics, & Behavior | .0521 | .0486 | .0036 | 2.5738 | .1091 |
| 3 - Environment & Culture | .3199 | .3180 | .0018 | 1.8547 | .1737 |

*df 1/df 2 = 1/683

Table 12

Summary of Comparisons of Models 2 and 3 for Social Studies-Environment:

Hypothesis that Opportunity to Learn Makes a Difference in Posttest Achievement

| Subscale | $R^2$ Full (Model 2) | $R^2$ Rest. (Model 3) | $R^2$ Diff. (Model 2- Model 3) | F* | P |
|---|---|---|---|---|---|
| 1 - America's Natural Beauty | .2308 | .2308 | .0000 | .0000 | 1.0000 |
| 2 - Westward Move | .2533 | .2391 | .0142 | 11.6334 | .0007 |
| 3 - Culture, Attitudes, & Environment | .1929 | .1909 | .0021 | 1.5656 | .2113 |
| 4 - Environmental Misuse | .2087 | .2086 | .0001 | .1077 | .7428 |

*df 1/df 2 = 1/611

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TABLE 13

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 1 BASIC MULTIPLICATION

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .7110 | .6961 | .0150 | .9053 | 2,35 | .4137 |
| 2 | .7122 | .6946 | .0177 | 1.0738 | 2,35 | .3527 |
| 3 | .6950 | .6933 | .0017 | .0989 | 2,35 | .9061 |
| 4 | .7048 | .6988 | .0059 | .3525 | 2,35 | .7054 |
| 5 | .6955 | .6944 | .0011 | .0619 | 2,35 | .9401 |
| 6 | .7371 | .7210 | .0161 | 1.0714 | 2,35 | .3535 |
| 7 | .7058 | .7000 | .0058 | .3427 | 2,35 | .7122 |
| 8 | .7438 | .7086 | .0352 | 2.4045 | 2,35 | .1051 |
| 9 | .7044 | .6962 | .0082 | .4831 | 2,35 | .6209 |
| 10 | .7325 | .7276 | .0049 | .3196 | 2,35 | .7286 |
| 11 | .7028 | .7021 | .0008 | .0445 | 2,35 | .9565 |

TABLE 14

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 2 FACTORS AND PRIME NUMBERS

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .5978 | .5866 | .0112 | .4888 | 2,35 | .6175 |
| 2 | .6184 | .6072 | .0112 | .5135 | 2,35 | .6028 |
| 3 | .5910 | .5890 | .0020 | .0847 | 2,35 | .9190 |
| 4 | .5873 | .5865 | .0008 | .0333 | 2,35 | .9673 |
| 5 | .5918 | .5881 | .0037 | .1592 | 2,35 | .8534 |
| 6 | .6057 | .6016 | .0041 | .1832 | 2,35 | .8334 |
| 7 | .6406 | .6016 | .0390 | 1.9006 | 2,35 | .1646 |
| 8 | .6050 | .5873 | .0177 | .7837 | 2,35 | .4646 |
| 9 | .6008 | .5900 | .0108 | .4740 | 2,35 | .6265 |
| 10 | .5993 | .5957 | .0036 | .1565 | 2,35 | .8557 |
| 11 | .5959 | .5919 | .0039 | .1706 | 2,35 | .8438 |

TABLE 15

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 3 BASIC DIVISION

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .6817 | .6751 | .0067 | .3672 | 2,35 | .6953 |
| 2 | .6932 | .6903 | .0030 | .1692 | 2,35 | .8450 |
| 3 | .6777 | .6750 | .0027 | .1446 | 2,35 | .8659 |
| 4 | .6763 | .6733 | .0030 | .1606 | 2,35 | .8523 |
| 5 | .6868 | .6744 | .0124 | .6931 | 2,35 | .5068 |
| 6 | .7184 | .7113 | .0071 | .4405 | 2,35 | .6473 |
| 7 | .7390 | .7051 | .0338 | 2.2676 | 2,35 | .1186 |
| 8 | .6750 | .6750 | .0000 | .0026 | 2,35 | .9974 |
| 9 | .6803 | .6788 | .0015 | .0841 | 2,35 | .9195 |
| 10 | .7378 | .7265 | .0113 | .7529 | 2,35 | .4785 |
| 11 | .6860 | .6749 | .0111 | .6180 | 2,35 | .5448 |

TABLE 16

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 4 BASIC FRACTIONS

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8569 | .8532 | .0037 | .4469 | 2,35 | .6432 |
| 2 | .8564 | .8563 | .0000 | .0040 | 2,35 | .9960 |
| 3 | .8577 | .8547 | .0030 | .3669 | 2,35 | .6955 |
| 4 | .8581 | .8532 | .0049 | .6092 | 2,35 | .5494 |
| 5 | .8679 | .8531 | .0147 | 1.9513 | 2,35 | .1572 |
| 6 | .8625 | .8613 | .0012 | .1539 | 2,35 | .8580 |
| 7 | .8560 | .8555 | .0005 | .0583 | 2,35 | .9434 |
| 8 | .8581 | .8541 | .0040 | .4906 | 2,35 | .6164 |
| 9 | .8558 | .8544 | .0014 | .1641 | 2,35 | .8493 |
| 10 | .8635 | .8625 | .0010 | .1290 | 2,35 | .8794 |
| 11 | .8650 | .8533 | .0117 | 1.5206 | 2,35 | .2327 |

TABLE 17

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 5 MEASUREMENT

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9587 | .9493 | .0094 | 3.9786 | 2,35 | .0277* |
| 2 | .9527 | .9485 | .0041 | 1.5294 | 2,35 | .2308 |
| 3 | .9518 | .9495 | .0023 | .8436 | 2,35 | .4387 |
| 4 | .9542 | .9495 | .0046 | 1.7706 | 2,35 | .1851 |
| 5 | .9520 | .9496 | .0024 | .8692 | 2,35 | .4281 |
| 6 | .9494 | .9489 | .0006 | .1927 | 2,35 | .8256 |
| 7 | .9514 | .9488 | .0025 | .9172 | 2,35 | .4090 |
| 8 | .9581 | .9488 | .0093 | 3.8805 | 2,35 | .0301* |
| 9 | .9485 | .9485 | .0000 | .0130 | 2,35 | .9871 |
| 10 | .9503 | .9485 | .0018 | .6430 | 2,35 | .5318 |
| 11 | .9489 | .9486 | .0004 | .1238 | 2,35 | .8839 |

TABLE 18

SUMMARY OF COMPARISONS OF SLOPES FOR GRS BY ABILITY GROUPS INTERACTION FOR MATH SCALE 6 GEOMETRY

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9054 | .9009 | .0045 | .8291 | 2,35 | .4448 |
| 2 | .9001 | .8999 | .0002 | .0344 | 2,35 | .9662 |
| 3 | .9030 | .9003 | .0027 | .4836 | 2,35 | .6206 |
| 4 | .9009 | .8997 | .0012 | .2139 | 2,35 | .8085 |
| 5 | .9070 | .8992 | .0078 | 1.4670 | 2,35 | .2444 |
| 6 | .9183 | .9083 | .0101 | 2.1607 | 2,35 | .1304 |
| 7 | .9036 | .9015 | .0021 | .3903 | 2,35 | .6798 |
| 8 | .9084 | .9000 | .0084 | 1.6098 | 2,35 | .2144 |
| 9 | .9044 | .8991 | .0053 | .9687 | 2,35 | .3895 |
| 10 | .9386 | .9122 | .0264 | 7.5123 | 2,35 | .0019* |
| 11 | .9086 | .8992 | .0095 | 1.8157 | 2,35 | .1777 |

TABLE 19

SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 1 BASIC MULTIPLICATION

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .6961 | .6840 | .0121 | .7357 | 2,37 | .4861 |
| 2 | .6946 | .6838 | .0108 | .6522 | 2,37 | .5268 |
| 3 | .6933 | .6805 | .0128 | .7704 | 2,37 | .4701 |
| 4 | .6988 | .6865 | .0124 | .7593 | 2,37 | .4751 |
| 5 | .6944 | .6811 | .0133 | .8044 | 2,37 | .4550 |
| 6 | .7210 | .7050 | .0160 | 1.0637 | 2,37 | .3555 |
| 7 | .7000 | .6884 | .0116 | .7168 | 2,37 | .4950 |
| 8 | .7086 | .6958 | .0128 | .8113 | 2,37 | .4520 |
| 9 | .6962 | .6841 | .0121 | .7368 | 2,37 | .4855 |
| 10 | .7276 | .7179 | .0097 | .6615 | 2,37 | .5221 |
| 11 | .7021 | .6863 | .0158 | .9793 | 2,37 | .3851 |

TABLE 20

-SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 2 FACTORS AND PRIME NUMBERS

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .5866 | .5685 | .0181 | .8098 | 2,37 | .4527 |
| 2 | .6072 | .5912 | .0160 | .7518 | 2,37 | .4786 |
| 3 | .5890 | .5693 | .0197 | .8862 | 2,37 | .4208 |
| 4 | .5865 | .5682 | .0184 | .8221 | 2,37 | .4474 |
| 5 | .5881 | .5694 | .0187 | .8405 | 2,37 | .4396 |
| 6 | .6016 | .5882 | .0133 | .6188 | 2,37 | .5441 |
| 7 | .6016 | .5859 | .0157 | .7296 | 2,37 | .4889 |
| 8 | .5873 | .5711 | .0162 | .7251 | 2,37 | .4910 |
| 9 | .5900 | .5708 | .0192 | .8671 | 2,37 | .4285 |
| 10 | .5957 | .5796 | .0161 | .7364 | 2,37 | .4857 |
| 11 | .5919 | .5728 | .0192 | .8683 | 2,37 | .4280 |

TABLE 21

SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 3 BASIC DIVISION

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .6751 | .6691 | .0060 | .3417 | 2,37 | .7128 |
| 2 | .6903 | .6871 | .0031 | .1879 | 2,37 | .8295 |
| 3 | .6750 | .6713 | .0037 | .2129 | 2,37 | .8093 |
| 4 | .6733 | .6698 | .0035 | .1988 | 2,37 | .8206 |
| 5 | .6744 | .6707 | .0037 | .2096 | 2,37 | .8119 |
| 6 | .7113 | .7002 | .0111 | .7146 | 2,37 | .4960 |
| 7 | .7051 | .7000 | .0051 | .3203 | 2,37 | .7279 |
| 8 | .6750 | .6716 | .0034 | .1934 | 2,37 | .8250 |
| 9 | .6788 | .6729 | .0058 | .3365 | 2,37 | .7165 |
| 10 | .7265 | .7211 | .0054 | .3628 | 2,37 | .6982 |
| 11 | .6749 | .6708 | .0041 | .2320 | 2,37 | .7941 |

TABLE 22

SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 4 BASIC FRACTIONS

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8532 | .8488 | .0044 | .5596 | 2,37 | .5762 |
| 2 | .8563 | .8507 | .0056 | .7208 | 2,37 | .4931 |
| 3 | .8547 | .8486 | .0061 | .7787 | 2,37 | .4664 |
| 4 | .8532 | .8477 | .0055 | .6909 | 2,37 | .5075 |
| 5 | .8531 | .8477 | .0054 | .6839 | 2,37 | .5109 |
| 6 | .8613 | .8553 | .0060 | .8022 | 2,37 | .4560 |
| 7 | .8555 | .8501 | .0055 | .6985 | 2,37 | .5038 |
| 8 | .8541 | .8488 | .0054 | .6797 | 2,37 | .5130 |
| 9 | .8544 | .8489 | .0055 | .7017 | 2,37 | .5022 |
| 10 | .8625 | .8553 | .0072 | .9665 | 2,37 | .3898 |
| 11 | .8533 | .8483 | .0050 | .6249 | 2,37 | .5409 |

TABLE 23

SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 5 MEASUREMENT

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9493 | .9470 | .0023 | .8408 | 2,37 | .4394 |
| 2 | .9485 | .9466 | .0019 | .6824 | 2,37 | .5117 |
| 3 | .9595 | .9479 | .0016 | .5856 | 2,37 | .5618 |
| 4 | .9495 | .9477 | .0018 | .6592 | 2,37 | .5232 |
| 5 | .9496 | .9478 | .0018 | .6582 | 2,37 | .5237 |
| 6 | .9489 | .9467 | .0022 | .7993 | 2,37 | .4572 |
| 7 | .9488 | .9470 | .0019 | .6732 | 2,37 | .5162 |
| 8 | .9488 | .9472 | .0016 | .5773 | 2,37 | .5664 |
| 9 | .9485 | .9466 | .0018 | .6634 | 2,37 | .5211 |
| 10 | .9485 | .9466 | .0019 | .6819 | 2,37 | .5119 |
| 11 | .9486 | .9467 | .0018 | .6631 | 2,37 | .5213 |

TABLE 24

SUMMARY OF COMPARISONS OF SLOPES FOR PRETEST BY ABILITY GROUPS INTERACTION FOR MATH SCALE 6 GEOMETRY

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9009 | .8993 | .0016 | .3021 | 2,37 | .7411 |
| 2 | .8999 | .8988 | .0011 | .2103 | 2,37 | .8113 |
| 3 | .9003 | .8987 | .0016 | .2935 | 2,37 | .7474 |
| 4 | .8997 | .8983 | .0014 | .2564 | 2,37 | .7752 |
| 5 | .8992 | .8980 | .0012 | .2181 | 2,37 | .8050 |
| 6 | .9083 | .9057 | .0026 | .5218 | 2,37 | .5978 |
| 7 | .9015 | .9010 | .0005 | .1003 | 2,37 | .9048 |
| 8 | .9000 | .8985 | .0015 | .2782 | 2,37 | .7587 |
| 9 | .8991 | .8980 | .0011 | .1962 | 2,37 | .8227 |
| 10 | .9122 | .9108 | .0014 | .2897 | 2,37 | .7502 |
| 11 | .8992 | .8980 | .0012 | .2156 | 2,37 | .8071 |

TABLE 25

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR CULTURE SCALE.1 PHYSICAL AND CULTURAL TRAITS

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .6275 | .6274 | .0001 | .0048 | 1,25 | .9452 |
| 2 | .6277 | .6274 | .0003 | .0190 | 1,25 | .8916 |
| 3 | .6304 | .6274 | .0030 | .2012 | 1,25 | .6577 |
| 4 | .6281 | .6274 | .0007 | .0466 | 1,25 | .8308 |
| 5 | .6314 | .6274 | .0040 | .2712 | 1,25 | .6071 |
| 6 | .6275 | .6274 | .0001 | .0072 | 1,25 | .9332 |
| 7 | .6275 | .6274 | .0002 | .0101 | 1,25 | .9207 |
| 8 | .6293 | .6274 | .0019 | .1276 | 1,25 | .7239 |
| 9 | .6350 | .6274 | .0077 | .5245 | 1,25 | .4756 |
| 10 | .6277 | .6274 | .0003 | .0220 | 1,25 | .8832 |
| 11 | .6274 | .6274 | .0000 | .0002 | 1,25 | .9896 |

TABLE 26

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR CULTURE SCALE 2 LEARNING, GENETICS AND BEHAVIOR

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9570 | .9570 | .0000 | .0161 | 1,25 | .8999 |
| 2 | .9570 | .9570 | .0000 | .0221 | 1,25 | .8829 |
| 3 | .9575 | .9570 | .0006 | .3265 | 1,25 | .5728 |
| 4 | .9616 | .9570 | .0047 | 3.0288 | 1,25 | .0941 |
| 5 | .9593 | .9570 | .0024 | 1.4622 | 1,25 | .2379 |
| 6 | .9589 | .9570 | .0020 | 1.2128 | 1,25 | .2813 |
| 7 | .9572 | .9570 | .0003 | .1639 | 1,25 | .6890 |
| 8 | .9590 | .9570 | .0020 | 1.2290 | 1,25 | .2781 |
| 9 | .9572 | .9570 | .0002 | .1377 | 1,25 | .7137 |
| 10 | .9570 | .9570 | .0000 | .0106 | 1,25 | .9189 |
| 11 | .9578 | .9570 | .0008 | .5023 | 1,25 | .4850 |

TABLE 27

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR CULTURE SCALE 3 ENVIRONMENT AND CULTURE

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8435 | .8411 | .0024 | .3803 | 1,25 | .5430 |
| 2 | .8415 | .8411 | .0004 | .0653 | 1,25 | .8004 |
| 3 | .8471 | .8411 | .0060 | .9761 | 1,25 | .3326 |
| 4 | .8440 | .8411 | .0029 | .4667 | 1,25 | .5008 |
| 5 | .8425 | .8411 | .0013 | .2107 | 1,25 | .6502 |
| 6 | .8415 | .8411 | .0003 | .0547 | 1,25 | .8170 |
| 7 | .8518 | .8411 | .0107 | 1.8076 | 1,25 | .1909 |
| 8 | .8466 | .8411 | .0054 | .8835 | 1,25 | .3562 |
| 9 | .8449 | .8411 | .0037 | .6035 | 1,25 | .4445 |
| 10 | .8416 | .8411 | .0005 | .0736 | 1,25 | .7884 |
| 11 | .8430 | .8411 | .0018 | .2926 | 1,25 | .5934 |

TABLE 28

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR CULTURE SCALE 4 INTERACTION AMONG CULTURES

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8400 | .8400 | .0000 | .0007 | 1,25 | .9793 |
| 2 | .8404 | .8400 | .0004 | .0613 | 1,25 | .8065 |
| 3 | .8418 | .8400 | .0017 | .2744 | 1,25 | .6050 |
| 4 | .8409 | .8400 | .0009 | .1352 | 1,25 | .7162 |
| 5 | .8409 | .8400 | .0008 | .1328 | 1,25 | .7186 |
| 6 | .8538 | .8400 | .0137 | 2.3447 | 1,25 | .1383 |
| 7 | .8403 | .8400 | .0003 | .0411 | 1,25 | .8409 |
| 8 | .8444 | .8400 | .0043 | .6957 | 1,25 | .4121 |
| 9 | .8463 | .8400 | .0063 | 1.0173 | 1,25 | .3228 |
| 10 | .8664 | .8400 | .0264 | 4.9369 | 1,25 | .0356* |
| 11 | .8482 | .8400 | .0082 | 1.3471 | 1,25 | .2568 |

TABLE 29

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR ENVIRONMENT SCALE 1 AMERICA'S NATURAL BEAUTY

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9148 | .8870 | .0279 | 9.1683 | 1,28 | .0052* |
| 2 | .9181 | .8870 | .0312 | 10.6600 | 1,28 | .0029* |
| 3 | .8894 | .8870 | .0024 | .6103 | 1,28 | .4412 |
| 4 | .8887 | .8870 | .0017 | .4400 | 1,28 | .5125 |
| 5 | .8940 | .8870 | .0070 | 1.8580 | 1,28 | .1837 |
| 6 | .8878 | .8870 | .0008 | .2108 | 1,28 | .6497 |
| 7 | .8897 | .8870 | .0027 | .6914 | 1,28 | .4127 |
| 8 | .8873 | .8870 | .0003 | .0826 | 1,28 | .7759 |
| 9 | .8903 | .8870 | .0034 | .8593 | 1,28 | .3619 |
| 10 | .8942 | .8870 | .0073 | 1.9270 | 1,28 | .1760 |
| 11 | .8894 | .8870 | .0025 | .6245 | 1,28 | .4360 |

TABLE 30

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT
FOR ENVIRONMENT SCALE 2 WESTWARD MOVE

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8998 | .8954 | .0045 | 1.2506 | 1,28 | .2729 |
| 2 | .8954 | .8954 | .0001 | .0174 | 1,28 | .8961 |
| 3 | .8957 | .8954 | .0003 | .0794 | 1,28 | .7802 |
| 4 | .8955 | .8954 | .0002 | .0450 | 1,28 | .8335 |
| 5 | .8970 | .8954 | .0017 | .4564 | 1,28 | .5048 |
| 6 | .8954 | .8954 | .0000 | .0082 | 1,28 | .9287 |
| 7 | .8955 | .8954 | .0001 | .0290 | 1,28 | .8660 |
| 8 | .8988 | .8954 | .0035 | .9570 | 1,28 | .3363 |
| 9 | .8956 | .8954 | .0003 | .0778 | 1,28 | .7823 |
| 10 | .8954 | .8954 | .0000 | .0014 | 1,28 | .9704 |
| 11 | .8957 | .8954 | .0003 | .0905 | 1,28 | .7658 |

TABLE 31

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR ENVIRONMENT SCALE 3 CULTURE, ATTITUDES, AND ENVIRONMENT

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .9077 | .9033 | .0044 | 1.3343 | 1,28 | .2578 |
| 2 | .9155 | .9033 | .0123 | 4.0750 | 1,28 | .0532 |
| 3 | .9049 | .9033 | .0017 | .4902 | 1,28 | .4896 |
| 4 | .9043 | .9033 | .0011 | .3103 | 1,28 | .5819 |
| 5 | .9046 | .9033 | .0014 | .3967 | 1,28 | .5339 |
| 6 | .9051 | .9033 | .0018 | .5402 | 1,28 | .4685 |
| 7 | .9053 | .9033 | .0020 | .6032 | 1,28 | .4439 |
| 8 | .9039 | .9033 | .0006 | .1809 | 1,28 | .6739 |
| 9 | .9035 | .9033 | .0002 | .0654 | 1,28 | .8001 |
| 10 | .9086 | .9033 | .0053 | 1.6265 | 1,28 | .2127 |
| 11 | .9038 | .9033 | .0005 | .1485 | 1,28 | .7028 |

TABLE 32

CONTRIBUTIONS OF THE GRS MEANS AS PREDICTORS OF ACHIEVEMENT FOR ENVIRONMENT SCALE 4 ENVIRONMENTAL MISUSE

| GRS | RSF | RSR | RSD | F | DF | P |
|---|---|---|---|---|---|---|
| 1 | .8160 | .8151 | .0009 | .1443 | 1,28 | .7069 |
| 2 | .8220 | .8151 | .0070 | 1.0997 | 1,28 | .3033 |
| 3 | .8188 | .8151 | .0037 | .5708 | 1,28 | .4562 |
| 4 | .8154 | .8151 | .0003 | .0484 | 1,28 | .8275 |
| 5 | .8180 | .8151 | .0029 | .4490 | 1,28 | .5083 |
| 6 | .8179 | .8151 | .0028 | .4370 | 1,28 | .5140 |
| 7 | .8175 | .8151 | .0025 | .3822 | 1,28 | .5414 |
| 8 | .8173 | .8151 | .0023 | .3491 | 1,28 | .5594 |
| 9 | .8152 | .8151 | .0001 | .0139 | 1,28 | .9071 |
| 10 | .8244 | .8151 | .0093 | 1.4880 | 1,28 | .2327 |
| 11 | .8226 | .8151 | .0075 | 1.1876 | 1,28 | .2851 |

TABLE 33

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 1 BASIC MULTIPLICATION

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .4188 | .4120 | .0068 | .3405 | 1,29 | .5640 | .4436 | .4188 | .0248 | 1.2475 | 1,28 | .2735 |
| 2 | .4136 | .4120 | .0016 | .0775 | 1,29 | .7827 | .4553 | .4136 | .0417 | 2.1457 | 1,28 | .1541 |
| 3 | .4184 | .4120 | .0064 | .3170 | 1,29 | .5777 | .4206 | .4184 | .0023 | .1094 | 1,28 | .7433 |
| 4 | .4142 | .4120 | .0022 | .1101 | 1,29 | .7424 | .4200 | .4142 | .0058 | .2793 | 1,28 | .6013 |
| 5 | .4206 | .4120 | .0086 | .4291 | 1,29 | .5176 | .4207 | .4206 | .0001 | .0059 | 1,28 | .9393 |
| 6 | .4791 | .4120 | .0671 | 3.7387 | 1,29 | .0630 | .4792 | .4791 | .0001 | .0056 | 1,28 | .9408 |
| 7 | .4146 | .4120 | .0026 | .1273 | 1,29 | .7238 | .4174 | .4146 | .0028 | .1356 | 1,28 | .7154 |
| 8 | .4489 | .4120 | .0370 | 1.9447 | 1,29 | .1738 | .4974 | .4489 | .0484 | 2.6989 | 1,28 | .1116 |
| 9 | .4194 | .4120 | .0074 | .3718 | 1,29 | .5468 | .4198 | .4194 | .0004 | .0194 | 1,28 | .8902 |
| 10 | .4238 | .4120 | .0118 | .5920 | 1,29 | .4479 | .4259 | .4238 | .0021 | .1038 | 1,28 | .7497 |
| 11 | .4135 | .4120 | .0016 | .0768 | 1,29 | .7837 | .4137 | .4135 | .0002 | .0074 | 1,28 | .9393 |

TABLE 34

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 2 FACTORS AND PRIME NUMBERS

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .3146 | .3117 | .0028 | .1200 | 1,29 | .7316 | .3406 | .3146 | .0260 | 1.1044 | 1,28 | .3023 |
| 2 | .3117 | .3117 | .0000 | .0001 | 1,29 | .9910 | .3800 | .3117 | .0683 | 3.0859 | 1,28 | .0899 |
| 3 | .3169 | .3117 | .0052 | .2212 | 1,29 | .6416 | .3398 | .3169 | .0229 | .9717 | 1,28 | .3327 |
| 4 | .3129 | .3117 | .0012 | .0516 | 1,29 | .8218 | .3913 | .3129 | .0784 | 3.6050 | 1,28 | .0680 |
| 5 | .3168 | .3117 | .0051 | .2151 | 1,29 | .6462 | .3177 | .3168 | .0009 | .0369 | 1,28 | .8491 |
| 6 | .3876 | .3117 | .0759 | 3.5942 | 1,29 | .0680 | .3884 | .3876 | .0008 | .0367 | 1,28 | .8495 |
| 7 | .3208 | .3117 | .0091 | .3897 | 1,29 | .5373 | .3436 | .3208 | .0227 | .9704 | 1,28 | .3330 |
| 8 | .3276 | .3117 | .0159 | .6862 | 1,29 | .4142 | .3582 | .3276 | .0306 | 1.3343 | 1,28 | .2578 |
| 9 | .3125 | .3117 | .0007 | .0314 | 1,29 | .8606 | .3127 | .3125 | .0002 | .0092 | 1,28 | .9243 |
| 10 | .3209 | .3117 | .0091 | .3903 | 1,29 | .5370 | .3230 | .3209 | .0021 | .0888 | 1,28 | .7679 |
| 11 | .3150 | .3117 | .0033 | .1384 | 1,29 | .7126 | .3686 | .3150 | .0537 | 2.3796 | 1,28 | .1342 |

TABLE 35

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 3 BASIC DIVISION

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .7858 | .7797 | .0061 | .8200 | 1,29 | .3727 | .7858 | .7858 | .0000 | .0041 | 1,28 | .9496 |
| 2 | .7908 | .7797 | .0111 | 1.5315 | 1,29 | .2258 | .7908 | .7908 | .0000 | .0029 | 1,28 | .9576 |
| 3 | .7974 | .7797 | .0177 | 2.5340 | 1,29 | .1223 | .7975 | .7974 | .0001 | .0073 | 1,28 | .9325 |
| 4 | .7888 | .7797 | .0091 | 1.2489 | 1,29 | .2729 | .7893 | .7888 | .0005 | .0704 | 1,28 | .7926 |
| 5 | .7892 | .7797 | .0095 | 1.3089 | 1,29 | .2620 | .7897 | .7892 | .0004 | .0578 | 1,28 | .8117 |
| 6 | .8302 | .7797 | .0505 | 8.6176 | 1,29 | .0065* | .8322 | .8302 | .0020 | .3329 | 1,28 | .5686 |
| 7 | .7798 | .7797 | .0001 | .0130 | 1,29 | .9098 | .7803 | .7798 | .0005 | .0581 | 1,28 | .8113 |
| 8 | .8062 | .7797 | .0265 | 3.9699 | 1,29 | .0558 | .8158 | .8062 | .0095 | 1.4474 | 1,28 | .2390 |
| 9 | .7809 | .7797 | .0012 | .1568 | 1,29 | .6950 | .7997 | .7809 | .0188 | 2.6262 | 1,28 | .1163 |
| 10 | .8298 | .7797 | .0501 | 8.5394 | 1,29 | .0067* | .8488 | .8298 | .0190 | 3.5220 | 1,28 | .0710 |
| 11 | .8101 | .7797 | .0304 | 4.6393 | 1,29 | .0397* | .8102 | .8101 | .0001 | .0178 | 1,28 | .8949 |

TABLE 36

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 4 BASIC FRACTIONS

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .8469 | .8435 | .0033 | .6325 | 1,29 | .4329 | .8476 | .8469 | .0008 | .1385 | 1,28 | .7126 |
| 2 | .8478 | .8435 | .0043 | .8202 | 1,29 | .3726 | .8535 | .3478 | .0057 | 1.0880 | 1,28 | .3058 |
| 3 | .8493 | .8435 | .0058 | 1.1187 | 1,29 | .2989 | .8646 | .8493 | .0153 | 3.1644 | 1,28 | .0861 |
| 4 | .8439 | .8435 | .0004 | .0779 | 1,29 | .7821 | .8490 | .8439 | .0051 | .9476 | 1,28 | .3387 |
| 5 | .8443 | .8435 | .0008 | .1430 | 1,29 | .7080 | .8451 | .8443 | .0009 | .1562 | 1,28 | .6957 |
| 6 | .8669 | .8435 | .0234 | 5.0903 | 1,29 | .0318* | .8696 | .8669 | .0027 | .5737 | 1,28 | .4551 |
| 7 | .8458 | .8435 | .0023 | .4317 | 1,29 | .5164 | .8462 | .8458 | .0004 | .0700 | 1,28 | .7933 |
| 8 | .8713 | .8435 | .0278 | 6.2733 | 1,29 | .0181* | .8718 | .8713 | .0005 | .1098 | 1,28 | .7428 |
| 9 | .8461 | .8435 | .0026 | .4847 | 1,29 | .4918 | .8472 | .8461 | .0011 | .1986 | 1,28 | .6593 |
| 10 | .8559 | .8435 | .0123 | 2.4821 | 1,29 | .1260 | .8574 | .8559 | .0016 | .3101 | 1,28 | .5820 |
| 11 | .8480 | .8435 | .0045 | .8609 | 1,29 | .3612 | .8494 | .8480 | .0014 | .2622 | 1,28 | .6127 |

TABLE 37

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 5 MEASUREMENT

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .9606 | .9589 | .0017 | 1.2397 | 1,29 | .2747 | .9617 | .9606 | .0011 | .8174 | 1,28 | .3737 |
| 2 | .9595 | .9589 | .0005 | .3839 | 1,29 | .5403 | .9597 | .9595 | .0002 | .1523 | 1,28 | .6993 |
| 3 | .9591 | .9589 | .0001 | .0893 | 1,29 | .7672 | .9646 | .9591 | .0055 | 4.3485 | 1,28 | .0463* |
| 4 | .9590 | .9589 | .0001 | .0549 | 1,29 | .8164 | .9612 | .9590 | .0022 | 1.5644 | 1,28 | .2214 |
| 5 | .9601 | .9589 | .0012 | .8438 | 1,29 | .3659 | .9601 | .9601 | .0000 | .0004 | 1,28 | .9837 |
| 6 | .9596 | .9589 | .0006 | .4607 | 1,29 | .5027 | .9630 | .9596 | .0034 | 2.5793 | 1,28 | .1195 |
| 7 | .9591 | .9589 | .0002 | .1220 | 1,29 | .7294 | .9592 | .9591 | .0001 | .0883 | 1,28 | .7685 |
| 8 | .9590 | .9589 | .0000 | .0155 | 1,29 | .9019 | .9656 | .9590 | .0066 | 5.3695 | 1,28 | .0280* |
| 9 | .9594 | .9589 | .0005 | .3480 | 1,29 | .5598 | .9596 | .9594 | .0001 | .0931 | 1,28 | .7626 |
| 10 | .9598 | .9589 | .0008 | .6070 | 1,29 | .4422 | .9617 | .9598 | .0019 | 1.3771 | 1,28 | .2505 |
| 11 | .9593 | .9589 | .0004 | .2816 | 1,29 | .5997 | .9594 | .9593 | .0000 | .0302 | 1,28 | .8632 |

TABLE 38

CONTRIBUTIONS OF THE GRS MEAN AND THE GRS SQUARED MEAN AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 6 GEOMETRY

| | MEAN | | | | | | SQUARED MEAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .9564 | .9557 | .0006 | .4141 | 1,29 | .5250 | .9564 | .9564 | .0000 | .0050 | 1,28 | .9443 |
| 2 | .9565 | .9557 | .0008 | .5273 | 1,29 | .4736 | .9566 | .9565 | .0001 | .0350 | 1,28 | .8530 |
| 3 | .9557 | .9557 | .0000 | .0010 | 1,29 | .9756 | .9584 | .9557 | .0027 | 1.8300 | 1,28 | .1870 |
| 4 | .9565 | .9557 | .0008 | .5317 | 1,29 | .4717 | .9611 | .9565 | .0046 | 3.2838 | 1,28 | .0807 |
| 5 | .9579 | .9557 | .0022 | 1.4930 | 1,29 | .2316 | .9579 | .9579 | .0000 | .0165 | 1,28 | .8987 |
| 6 | .9592 | .9557 | .0035 | 2.4954 | 1,29 | .1250 | .9592 | .9592 | .0000 | .0006 | 1,28 | .9806 |
| 7 | .9558 | .9557 | .0001 | .0598 | 1,29 | .8085 | .9559 | .9558 | .0000 | .0304 | 1,28 | .8628 |
| 8 | .9560 | .9557 | .0002 | .1583 | 1,29 | .6936 | .9606 | .9560 | .0047 | 3.3241 | 1,28 | .0790 |
| 9 | .9559 | .9557 | .0002 | .1067 | 1,29 | .7463 | .9600 | .9559 | .0041 | 2.8530 | 1,28 | .1023 |
| 10 | .9587 | .9557 | .0030 | 2.0952 | 1,29 | .1585 | .9587 | .9587 | .0000 | .0009 | 1,28 | .9765 |
| 11 | .9557 | .9557 | .0000 | .0125 | 1,29 | .9119 | .9560 | .9557 | .0002 | .1498 | 1,28 | .7017 |

TABLE 39

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 1 BASIC MULTIPLICATION

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .4629 | .4436 | .0193 | .9714 | 1,27 | .3331 | .4672 | .4629 | .0043 | .2107 | 1,26 | .6500 |
| 2 | .4714 | .4553 | .0161 | .8212 | 1,27 | .3728 | .4721 | .4114 | .0007 | .0353 | 1,26 | .8524 |
| 3 | .4523 | .4206 | .0317 | 1.5613 | 1,27 | .2222 | .4765 | .4523 | .0243 | 1.2048 | 1,26 | .2824 |
| 4 | .4321 | .4200 | .0121 | .5738 | 1,27 | .4553 | .4775 | .4321 | .0454 | 2.2613 | 1,26 | .1447 |
| 5 | .4511 | .4207 | .0304 | 1.4950 | 1,27 | .2320 | .4873 | .4511 | .0362 | 1.8381 | 1,26 | .1868 |
| 6 | .5055 | .4792 | .0262 | 1.4307 | 1,27 | .2421 | .5608 | .5055 | .0554 | 3.2777 | 1,26 | .0818 |
| 7 | .4694 | .4174 | .0521 | 2.6489 | 1,27 | .1152 | .5270 | .4694 | .0575 | 3.1628 | 1,26 | .0870 |
| 8 | .5479 | .4974 | .0505 | 3.0179 | 1,27 | .0937 | .5835 | .5479 | .0355 | 2.2180 | 1,26 | .1484 |
| 9 | .4201 | .4198 | .0003 | .0139 | 1,27 | .9069 | .4391 | .4201 | .0190 | .8797 | 1,26 | .3569 |
| 10 | .4319 | .4259 | .0060 | .2837 | 1,27 | .5986 | .4640 | .4319 | .0322 | 1.5599 | 1,26 | .2228 |
| 11 | .4250 | .4137 | .0120 | .5636 | 1,27 | .4593 | .4528 | .4257 | .0271 | 1.2859 | 1,26 | .2672 |

TABLE 40

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 2 FACTORS AND PRIME NUMBERS

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .3406 | .3406 | .0000 | .0013 | 1,27 | .9716 | .3446 | .3406 | .0040 | .1578 | 1,26 | .6944 |
| 2 | .3850 | .3800 | .0050 | .2182 | 1,27 | .6442 | .3852 | .3850 | .0001 | .0061 | 1,26 | .9384 |
| 3 | .3844 | .3398 | .0445 | 1.9534 | 1,27 | .1736 | .4184 | .3844 | .0340 | 1.5188 | 1,26 | .2288 |
| 4 | .4347 | .3913 | .0434 | 2.0707 | 1,27 | .1616 | .4653 | .4347 | .0307 | 1.4921 | 1,26 | .2328 |
| 5 | .3652 | .3177 | .0475 | 2.0188 | 1,27 | .1668 | .3942 | .3652 | .0290 | 1.2467 | 1,26 | .2744 |
| 6 | .4028 | .3884 | .0144 | .6498 | 1,27 | .4272 | .4603 | .4028 | .0575 | 2.7708 | 1,26 | .1080 |
| 7 | .3798 | .3436 | .0362 | 1.5760 | 1,27 | .2201 | .3882 | .3798 | .0084 | .3575 | 1,26 | .5551 |
| 8 | .3744 | .3582 | .0162 | .6970 | 1,27 | .4111 | .3761 | .3744 | .0017 | .0705 | 1,26 | .7928 |
| 9 | .3629 | .3127 | .0502 | 2.1263 | 1,27 | .1563 | .4119 | .3629 | .0490 | 2.1683 | 1,26 | .1529 |
| 10 | .3248 | .3230 | .0018 | .0738 | 1,27 | .7879 | .4064 | .3248 | .0815 | 3.5716 | 1,26 | .0700 |
| 11 | .3788 | .3686 | .0102 | .4430 | 1,27 | .5113 | .3865 | .3788 | .0077 | .3269 | 1,26 | .5724 |

TABLE 41

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 3 BASIC DIVISION

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .7961 | .7858 | .0103 | 1.3605 | 1,27 | .2537 | .8046 | .7961 | .0085 | 1.1377 | 1,26 | .2959 |
| 2 | .7914 | .7908 | .0006 | .0808 | 1,27 | .7783 | .7949 | .7914 | .0035 | .4406 | 1,26 | .5127 |
| 3 | .8020 | .7975 | .0046 | .6206 | 1,27 | .4377 | .8081 | .8020 | .0061 | .8215 | 1,26 | .3731 |
| 4 | .7897 | .7893 | .0004 | .0495 | 1,27 | .8255 | .8213 | .7897 | .0316 | 4.5922 | 1,26 | .0416* |
| 5 | .7931 | .7897 | .0034 | .4449 | 1,27 | .5104 | .8090 | .7931 | .0160 | 2.1734 | 1,26 | .1524 |
| 6 | .8331 | .8322 | .0009 | .1507 | 1,27 | .7009 | .8415 | .8331 | .0084 | 1.3819 | 1,26 | .2504 |
| 7 | .7846 | .7803 | .0044 | .5473 | 1,27 | .4658 | .7889 | .7846 | .0043 | .5286 | 1,26 | .4737 |
| 8 | .8449 | .8158 | .0291 | 5.0643 | 1,27 | .0328* | .8685 | .8449 | .0236 | 4.6747 | 1,26 | .0400* |
| 9 | .8006 | .7997 | .0010 | .1292 | 1,27 | .7220 | .8009 | .8006 | .0002 | .0290 | 1,26 | .8662 |
| 10 | .8531 | .8488 | .0042 | .7770 | 1,27 | .3858 | .8571 | .8531 | .0040 | .7358 | 1,26 | .3989 |
| 11 | .8342 | .8102 | .0240 | 3.9120 | 1,27 | .0582 | .8343 | .8342 | .0001 | .0029 | 1,26 | .9577 |

TABLE 42

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 4 BASIC FRACTIONS

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .8477 | .8476 | .0001 | .0093 | 1,27 | .9240 | .8477 | .8477 | .0000 | .0018 | 1,26 | .9663 |
| 2 | .8554 | .8535 | .0019 | .3551 | 1,27 | .5562 | .8601 | .8554 | .0047 | .8674 | 1,26 | .3602 |
| 3 | .8671 | .8646 | .0025 | .4987 | 1,27 | .4861 | .8689 | .8671 | .0018 | .3581 | 1,26 | .5548 |
| 4 | .8588 | .8490 | .0097 | 1.8563 | 1,27 | .1843 | .8745 | .8588 | .0158 | 3.2676 | 1,26 | .0822 |
| 5 | .8730 | .8451 | .0279 | 5.9247 | 1,27 | .0218* | .8731 | .8730 | .0001 | .0174 | 1,26 | .8960 |
| 6 | .8707 | .8696 | .0012 | .2422 | 1,27 | .6266 | .8723 | .8707 | .0016 | .3247 | 1,26 | .5737 |
| 7 | .8463 | .8462 | .0001 | .0102 | 1,27 | .9202 | .8463 | .8463 | .0000 | .0021 | 1,26 | .9637 |
| 8 | .8816 | .8718 | .0097 | 2.2184 | 1,27 | .1480 | .8898 | .8816 | .0082 | 1.9324 | 1,26 | .1763 |
| 9 | .8510 | .8472 | .0038 | .6860 | 1,27 | .4148 | .8510 | .8510 | .0000 | .0001 | 1,26 | .9919 |
| 10 | .8574 | .8574 | .0000 | .0000 | 1,271 | .0000 | .8627 | .8574 | .0053 | 1.0031 | 1,26 | .3258 |
| 11 | .8498 | .8494 | .0003 | .0624 | 1,27 | .8046 | .8538 | .8498 | .0041 | .7225 | 1,26 | .4031 |

TABLE 43

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 5 MEASUREMENT

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .9649 | .9617 | .0032 | 2.4296 | 1,27 | .1307 | .9650 | .9649 | .0001 | .0373 | 1,26 | .8483 |
| 2 | .9604 | .9597 | .0007 | .4716 | 1,27 | .4981 | .9615 | .9604 | .0011 | .7205 | 1,26 | .4037 |
| 3 | .9647 | .9646 | .0001 | .0922 | 1,27 | .7637 | .9647 | .9647 | .0000 | .0167 | 1,26 | .8982 |
| 4 | .9614 | .9612 | .0002 | .1275 | 1,27 | .7238 | .9620 | .9614 | .0006 | .3951 | 1,26 | .5351 |
| 5 | .9605 | .9601 | .0004 | .2427 | 1,27 | .6263 | .9605 | .9605 | .0000 | .0166 | 1,26 | .8986 |
| 6 | .9638 | .9630 | .0008 | .6055 | 1,27 | .4433 | .9673 | .9638 | .0035 | 2.7858 | 1,26 | .1071 |
| 7 | .9593 | .9592 | .0001 | .0654 | 1,27 | .8001 | .9596 | .9593 | .0003 | .1853 | 1,26 | .6704 |
| 8 | .9658 | .9656 | .0002 | .1629 | 1,27 | .6897 | .9665 | .9658 | .0008 | .5863 | 1,26 | .4507 |
| 9 | .9597 | .9596 | .0002 | .1098 | 1,27 | .7429 | .9600 | .9597 | .0003 | .2013 | 1,26 | .6574 |
| 10 | .9618 | .9617 | .0001 | .0621 | 1,27 | .8051 | .9626 | .9618 | .0008 | .5681 | 1,26 | .4578 |
| 11 | .9595 | .9594 | .0001 | .0706 | 1,27 | .7925 | .9599 | .9595 | .0004 | .2338 | 1,26 | .6328 |

TABLE 44

CONTRIBUTIONS OF THE GRS VARIANCE AND THE GRS SQUARED VARIANCE AS PREDICTORS OF ACHIEVEMENT FOR MATH SCALE 6 GEOMETRY

| | VARIANCE | | | | | | SQUARED VARIANCE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRS | RSF | RSR | RSD | F | DF | P | RSF | RSR | RSD | F | DF | P |
| 1 | .9573 | .9564 | .0009 | .5992 | 1,27 | .4456 | .9577 | .9573 | .0004 | .2590 | 1,26 | .6151 |
| 2 | .9597 | .9566 | .0031 | 2.1008 | 1,27 | .1587 | .9599 | .9597 | .0002 | .1446 | 1,26 | .7068 |
| 3 | .9590 | .9584 | .0006 | .3715 | 1,27 | .5473 | .9593 | .9590 | .0003 | .2029 | 1,26 | .6561 |
| 4 | .9611 | .9611 | .0000 | .0213 | 1,27 | .8851 | .9677 | .9611 | .0066 | 5.2964 | 1,26 | .0296* |
| 5 | .9579 | .9579 | .0000 | .0024 | 1,27 | .9616 | .9581 | .9579 | .0002 | .0942 | 1,26 | .7614 |
| 6 | .9633 | .9592 | .0041 | 2.9969 | 1,27 | .0948 | .9647 | .9633 | .0014 | 1.0588 | 1,26 | .3130 |
| 7 | .9560 | .9559 | .0001 | .0537 | 1,27 | .8184 | .9561 | .9560 | .0001 | .0771 | 1,26 | .7835 |
| 8 | .9619 | .9606 | .0013 | .9133 | 1,27 | .3477 | .9622 | .9619 | .0002 | .1585 | 1,26 | .6938 |
| 9 | .9600 | .9600 | .0000 | .0519 | 1,27 | .8216 | .9605 | .9600 | .0004 | .2915 | 1,26 | .5938 |
| 10 | .9607 | .9587 | .0020 | 1.3695 | 1,27 | .2521 | .9615 | .9607 | .0008 | .5301 | 1,26 | .4731 |
| 11 | .9665 | .9560 | .0105 | 8.4711 | 1,27 | .0071* | .9666 | .9665 | .0001 | .0914 | 1,26 | .7649 |